General Geologic Setting

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The East Mojave National Scenic Area (EMNSA), located in southeastern California (figs. 1, 2), lies in the northeastern Mojave Desert (fig. 3), a large physiographic province whose extent is defined by its Neogene geologic history. The desert physiography consists of ranges that are separated by basins either filled by alluvial materials or underlain at shallow depths by pediments. In the EMNSA several ranges attain greater than 7,000–ft (2,133–m) elevations, some 5,000 ft (1,524 m) above the alluvial valley floors; extensive range-fringing pediments are present and some spectacular pediment domes are developed.

The diverse geologic history of the EMNSA spans more than 1,760 million years (m.y.). The oldest rocks, which underlie much of the northern part of the area, are Early Proterozoic gneisses that underwent regional metamorphism at high metamorphic grades about 1,700 million years ago (Ma). These rocks were subsequently intruded by granitic rocks from about 1,695 to 1,650 Ma, again by granitic rocks at about 1,400 Ma, and by diabase at about 1,100 Ma. Unique carbonatites and alkaline igneous rocks compose part of the 1,400–Ma intrusive episode. Latest Proterozoic, Paleozoic, and early Mesozoic sedimentary strata were deposited unconformably across the Proterozoic gneissic and granitic rocks. These sedimentary rocks formed in marine and, less commonly, continental environments along the west edge of the North America craton and represent the transition from the cratonal sedimentary sequence in the southeast to a miogeoclinal sequence in the northwest.

Beginning in the Mesozoic, widespread magmatism affected the region. Triassic volcanic rocks, locally present in several ranges in the western part of the EMNSA, represent the oldest products of this magmatism. Jurassic volcanism and plutonism produced rocks with slight alkalic affinities that lie along the east edge of the magmatic arc of that age. Subsequent plutonism in the Cretaceous is characterized by rocks of calc-alkaline affinities, typical of batholithic rocks within the cores of continental magmatic arcs. During the middle to late Mesozoic, the interior of the cordillera underwent shortening along a fold and thrust belt. Thrust slices within this belt in the EMNSA involve the cratonal Proterozoic basement and, locally, some of the Mesozoic plutonic rocks.

A period of tectonic quiescence characterized the region in the early Cenozoic. In the Miocene, volcanism became widespread along the south and east margins of the EMNSA and possibly elsewhere. Significant extensional deformation occurred in metamorphic core complexes during the Miocene both in northern parts and in areas largely just outside of the EMNSA, as well as along the lower Colorado River to the east and in the central Mojave Desert to the southwest (lightly shaded areas, fig. 3). This deformation is characterized by the structural superposition of intensely faulted, upper-crustal rocks over midcrustal rocks along regionally subhorizontal detachment faults, several of which project underneath rocks now exposed in the EMNSA. The near-surface rocks of the EMNSA, however, apparently escaped much of this intense extensional deformation. High-angle faults cut several ranges, and many faults possibly have undergone several periods of movement, which date back to Mesozoic time. Some faults are of local importance to the physiographic development of the ranges and basins and, in places, seem to have controlled formation of various kinds of ore bodies and mineral occurrences.

In the late Miocene, extensive erosion produced broad pediment domes in the northwestern part of the area. Alkali-basaltic volcanism followed pediment formation in the late Miocene and Pliocene (frontispiece). Erosion during the Quaternary has continued to degrade the pediment domes and mountain ranges and to supply sediments to adjacent valleys.

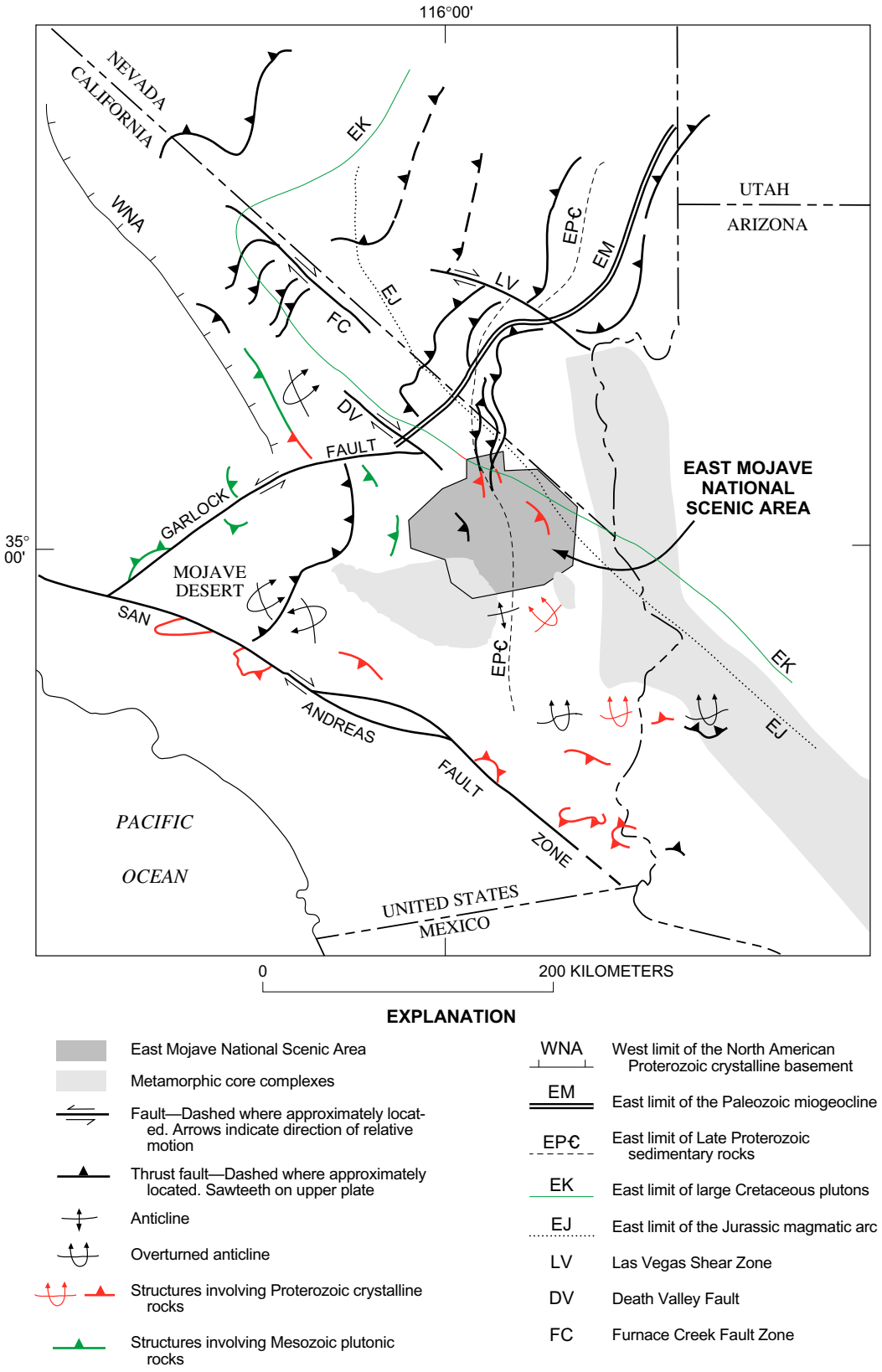

Figure 3. Schematic tectonic map of southeastern California and adjoining regions, showing relations among major structural and paleogeographic elements. Vergence of major overturned folds also shown. Modified from Burchfiel and Davis (1981, 1988) and Brown (1986).